# Ultramicro, Nonlethal, and Reversible: Looking Ahead to Military Biotechnology

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AFTER TWO world wars, the invention of nuclear weapons, and the Cold War, our world is undergoing a military revolution characterized by electronics, computers, communications, and microinformation technology. In recent wars, this progress has produced fewer casualties (both civilian and military), and the desire to cause fewer casualties has become an important factor restricting military operations.[1]

Biotechnology is developing quite rapidly and has had an enormous effect on the progress of science and technology, as well as on the global economy. In the field of military affairs, modern biotechnology maintains a rapid pace of development and plays an important role in medical protection. However, it is gradually revealing a character of aggression as well. Therefore, it is of increasing military value.

Mainstream science and technology extend from the land to the seas, air, and space. In an age that emphasizes the command of information, we have begun to explore a new technological space. Today, the modern biotechnology that focuses on the microcosmos of the life structure can directly explore the main entity of war—human beings themselves—thus taking precise control of the battle effectiveness of enemies. As Prussian strategist Carl von Clausewitz said, "War . . . is an act of violence intended to compel our opponent to fulfill our will."[2] Clausewitz scholar Wu Qiong adds, "Conceptually, to deprive the enemy of the power of resistance is the real aim of war."[3]

Compared with wars in the past, war through the command of biotechnology will guarantee the free application and security of our own biotechnology and, ultimately, lead to success through ultramicro, nonlethal, and reversible effects. Biotechnology is likely to bring about profound changes in the military domain and will contribute the utmost to the protection of civilization.

## Possible Military Uses of Biotechnology

Modern biotechnology is now in full blossom. Since the 1990s, half of the "Breakthroughs of the Year" selected by *Science* magazine have been in the biotechnology and life sciences fields. Such innovations (outlined below) are of great medical value and can be of great value in military affairs as well.[4]

**The Human Genome Project (HGP).** The HGP explores the new world of biotechnology, defines the microcosmos of life science, and lifts medical research and practice to new levels, such as individualized and ethnical medicine. It also provides possibilities for military use. Revealing genetic structure, the structure-function relationship, and the structure-health relationship can deepen the understanding of how to control and change a human being's battle effectiveness.

**Bioinformatics**. The study of gene and protein molecules is rapidly expanding to other domains. Those who master more bioinformation faster will take the lead in military biotechnology

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development and application.

**Proteomics**. From the perspective of military medicine, proteomics, which examines the structure-function relationship at the molecular level, is a bridge between military goals and practical technologies. With the development of proteomics, we can discover and interpret the key proteins in any single human physiological function and the multiple physiological functions any single protein possesses. All of this will provide accurate models for military attack and make it possible to develop small-scale or ultramicro-scale destructive weapons.

**Transgenic technology.** The new transgenic technology currently has limited uses, but its idea of gene control and reconstitution has possibilities for military use. The results from studies in this domain will help the military set goals in command and control.

Besides the innovations listed above, many other newly developed biotechnologies lend themselves to military purposes; for example, DNA recombination, gene modification, gene cloning, exogenous gene expression synergy, gene targeting, stem cell technology, tissue engineering, and so on. These biotechnologies will vastly enrich the military's ability to defend and attack.

## Aggressive Biotechnology

Modern biotechnology has played an important role in treatment of war injuries, prevention and diagnosis of diseases, and protection against biochemical toxic agents; it will show its advantages in strengthening the power to fight, resist fatigue, sense and monitor the battlefield, and develop military biomaterials.[5] We can use many modern biotechnologies directly as a means of defense and attack, and with further development, they probably will become new weapons systems. Such biotechnologies have the features discussed in the following paragraphs:

**Direct effects.** Direct-effect weapons can be used on human bodies to alter their biological features. Modern biotechnology looks at life in a new way—at the molecular level. Many unknown or unidentified substances of physiological activity have been discovered, and the structure-function relationship of biomacromolecules has been clarified. As a result, we might soon be able to design, control, reconstruct, and simulate molecules in living beings. Methods to change and rebuild biological features and biomolecule functions will soon appear in great number. Genome and proteome technologies can accurately modify living tissues according to precise procedures and conditions. Through the interaction of proteins, we can modify cell functions as needed. In the final analysis, war is simply human behavior that forces enemies to lose the power of resistance. Biotechnological weapons can cause destruction that is both more powerful and more civilized than that caused by conventional killing methods like gunpowder or nuclear weapons.

**Reversible wounds.** Modern biotechnology reveals pathologies of products that can do great harm to people. It can also provide effective ways to explore human health hazards. We can also use this knowledge during war to damage and injure individuals in a more accurate, effective fashion. We can choose military biotechnologies with different pathogenic factors to achieve various military goals. A military attack, therefore, might wound an enemy's genes, proteins, cells, tissues, and organs, causing more damage than conventional weapons could. However, such devastating, nonlethal effects will require us to pacify the enemy through postwar reconstruction efforts and hatred control.[6]

**Multiple vulneration.** Modern biotechnology makes it possible to combine two or more pathogenic genes and place them inside a susceptible living body to create a multiple-vulnerating effect. In addition, delaying the time required for a causative agent to take effect is possible by using a living body with a relatively longer incubation period or a pathogenic living body that produces no symptoms when inserted into the human body. When some other factor activates the causative agents, a timed causation of disease or pathopoiesis is possible. What is more, it is now possible to make bioproducts that can target and destroy an enemy's armaments and food and water sources. For example, rubber-invading compounds can attack rubber goods exclusively.[7]

## Directional-effect Biotechnologies

We can now hypothesize highly directional biotechnologies as described in the following paragraph:

**Organismic vector transfer.** As the application of viral vectors in gene therapy shows, the stable expression of the exogenous virulence gene transfected to targeted people via retrovirus, adenovirus, or an adenoassociated virus can cause disease or injury.[8] As transfection technology develops, more viral vectors or other organismic vectors will be found, which will enable vector transfer to be more suitable for war.

**Directed-energy-induced mutation**. High-intensity ultraviolet rays and electromagnetic waves can induce genetic-locus cell mutation.[9] If we determine the relationship between the specific frequency, wavelength, or power of the ray or wave and the specific gene or locus, we can cause injury by remote, radiation-induced, genetic function changes.

**Direct integration**. University of Wisconsin scientists have made exogenous, naked DNA and injected it into veins for easy access into muscle cells for gene therapy. By combining this knowledge and particle-gun technology, we could create a microbullet out of a 1-μm tungsten or gold ion, on whose surface plasmid DNA or naked DNA could be precipitated, and deliver the bullet via a gunpowder explosion, electron transmission, or high-pressured gas to penetrate the body surface.[10] We could then release DNA molecules to integrate with the host's cells through blood circulation and cause disease or injury by controlling genes.

## The Superiority of Biotechnological Weapons

Biological tag-tracing, electromagnetic targeting, and nanometer biological technologies can help build highly military-oriented biotechniques. While it is perhaps too early to decide what form modern biotechnological weapons might take, one thing is sure: all such weapons require a military that focuses on information more than on mechanization. In an environment where information is processed rapidly, the battlefield is more transparent, positioning is more accurate, and with the help of material science and nanometer technology, we can finally make revolutionary breakthroughs.

How to turn modern biotechnology to make actual weapons today is still not known, but with their capability of attacking targets accurately and producing ultramicro, nonlethal, and reversible damage, such weapons might finally change the methods of "physical annihilation" or "destruction within the killing range" which have characterized war since the invention of gunpowder. Humaneness in the conduct of war has become the focus of attention recently, and weapons of mass destruction are banned to reduce casualties. The times call for new kinds of weapons, and modern biotechnology can contribute such weapons, which might have the following vulnerating characteristics:

**Specificity of wounding.** Precision injury is an embodiment of specificity. HGP and proteomics have greatly enriched bioinformation. If we acquire a target's genome and proteome information, including those of ethnic groups or individuals, we could design a vulnerating agent that attacks only key enemies without doing any harm to ordinary people. We could also confine the attack to a more precise level. Injuries might be limited to a specific gene sequence or a specific protein structure. Through gene manipulation, we can attack or injure one or more key human physiological functions (the ability to learn, memorize, keep one's balance, or perform fine motor activities and even act aggresively) without a threat to life.

**Ultramicro damage**. When attacking an enemy with biotechnological military weapons, we could choose targets from a nucleotide sequence or protein structure. We could cause physiological dysfunction by producing an ultramicro damaging effect to a gene's or a protein's structure and functioning. Precision injury and ultramicro damage are two vulnerating methods based on genomics and proteomics. Because they target the primary structure of the gene or protein, they are completely different from traditional weapons of war that directly damage tissues and organs.

**Crypticity.** Although applications of military biotechnology are complicated, the finished products are convenient to carry, easy to use, and do not require large support systems. Detecting and predicting their use is difficult. Only after obvious wounding occurs will enemies realize they are under attack. In this sense, using military biotechnology weapons is a good tactic.

**Controllability and recoverability.** Unlike weapons that use ammunition whose damaging effects can only be ascertained after shooting, we can test in a laboratory the degree of damage biotechnological weapons produce. We can control the degree of injuries and damage produced and even provide an antidote or a cure (a vaccine, a countervulnerating agent, or a piece of bioinformation). Providing such an anodyne to our enemies would represent real "mercy."

**Difficulty in taking precautions.** Because of the sheer number of living bodies military biotechnology can use, the reformed (managed) gene order or protein structure is like a specially made lock: Only the developer has the key, and it is difficult for enemies to unlock. Because so many human genes and proteins are vulnerable to attack in so many ways, definite diagnosis and prompt treatment of injury is difficult. So, how and when can we take precautions against attacks?

## Biotechnological vs. Biological Weapons

Modern military biotechnology, which is biotechnology applied in the military domain to produce weapons-like effects, is fundamentally different from traditional biological weapons. The confusion of the two concepts is not scientific and is not helpful to the proper development of military biotechnology or the final elimination of traditional biological weapons.

Traditional biological weapons aim to produce mass destruction. They reduce the enemy's fighting power by damaging a large number of human beings, livestock, crops, and even the ecological system. Biological weapons of mass destruction originated from the idea that the more they kill and the fiercer the disasters they produce, the better they are. Technologically, traditional biological weapons depend on microbiology, especially bacteriology, which uses destructive bacteria, viruses, and toxic living bodies obtained directly from the natural world. These weapons are subject to nature, are difficult to control, and have irreversible effects. The use of such weapons is opposed by most countries in the world.

In the 1970s, DNA recombination technology symbolized the birth of modern biotechnology. As seen in the examples mentioned, current military biotechnology possesses a quality of "mercy," and its action, purpose of study, and specifications are totally different from traditional biological weapons. Modern biotechnology will help rid the world of primitive forms of microorganisms, biological agents and toxins; offer an alternative to biological warfare; and, ultimately, help eliminate traditional biological weapons. However, modern biotechnology has a long way to go, so it is still necessary to regulate it in order to develop it in the correct direction. The Chemical Weapons Convention or similar international conventions must ensure military biotechnology is never abused or misused.

## Not Yet an Instrument of Military Power

Military biotechnology has not yet become an instrument of military power. The laws, rules, and essential qualities of modern biotechnology have not yet been clarified. We cannot use and control it at our will. Progress is still needed in supporting areas such as military information technologies and material science. Even so, the increased pace of development of modern biotechnology tells us that the day on which we will begin to make full military use of its advantages is not too far off.

We believe that command of military biotechnology is a reasonable scientific presumption, not a scientific illusion. In the near future, when military biotechnology is highly developed, modern biotechnology will have a revolutionary influence on the organization of military power with its more direct effects on the main entity of war—human beings. Modern biotechnology offers an enormous potential military advantage. ***MR***


### NOTES

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